

CLAIMS:

1. A ceramic matrix composite material comprising:

non-oxide ceramic fibers, which are formed in a complex fiber architecture by conventional textile processes;

a thin mechanically weak interphase material, which is coated on the fibers;

5 and

a non-oxide or oxide ceramic matrix, which is formed within the interstices of the interphase-coated fiber architecture;

wherein during composite fabrication or post treatment, the interphase is allowed to debond from the matrix while still adhering to the fibers, thereby providing enhanced oxidative durability and damage tolerance to the fibers and the composite material.

10

2. The ceramic matrix composite as recited in claim 1, wherein components of the ceramic matrix composite material are selected to create a residual tensile/shear stress between the interphase material and the non-oxide or oxide matrix upon cool-down from matrix fabrication temperature, and the interphase is made to be more weakly bound to the non-oxide or oxide matrix than to the non-oxide fibers.

3. The ceramic matrix composite as recited in claim 1, wherein a not fully crystalline interphase is produced at a lower temperature than the matrix and fiber production temperatures and the as-fabricated composite material is subjected to a post heat treatment to cause shrinkage due to densification of the interphase coating

while maintaining as-produced fiber performance.

4. The ceramic matrix composite as recited in claim 1, wherein the non-oxide fibers comprise chemical compositions based on silicon carbide with microstructures thermally stable to temperatures above 1600°C.

5. The ceramic matrix composite as recited in claim 1, wherein the interphase material comprises chemical compositions based on at least one of boron nitride, silicon carbide, silicon nitride, silicon-doped boron nitride, and other non-oxide and oxides that are non reactive with the non-oxide fibers.

6. The ceramic matrix composite as recited in claim 1, wherein the interphase material is dimensionally unstable and capable of shrinkage at temperatures below 1600°C.

7. The ceramic matrix composite as recited in claim 1, wherein the deposition conditions for the non-oxide matrix results in an initial dense layer with a chemical composition based on silicon carbide.

8. A method of forming a ceramic matrix composite, the method comprising the steps of:

selecting chemical compositions for non-oxide fibers, a thin and mechanically weak interphase material, and a non-oxide or oxide matrix;

- 5 forming the non-oxide fibers into complex architectures;
 depositing the thin and mechanically weak interphase material on the non-oxide fibers;
 depositing the non-oxide or oxide matrix on the interphase material;
 processing the non-oxide fibers, the interphase material, and the non-oxide or
10 oxide matrix such that, after a final composite processing, debonding or mechanical decoupling is already achieved between the interphase material and the non-oxide or oxide matrix.

9. The method as recited in claim 8, wherein the chemical compositions of the non-oxide fibers, non-oxide or oxide matrix, and an outer surface layer of the interphase or an inner surface layer of the matrix are selected so that, during composite processing, sufficient residual stress exists in the composite to debond the interphase material from the matrix while retaining a mechanical bond between the interphase and fibers.

10. The method as recited in claim 8, wherein the processing step comprises subjecting the composite to a heat treatment at a temperature that causes shrinkage of the interphase coating.

11. The method as recited in claim 10, wherein non-oxide fiber types and matrix morphologies and compositions are selected to be microstructurally stable at temperatures above the interphase formation temperature.

12. The method as recited in claim 10, wherein the non-oxide fibers comprise thermally stable chemical compositions based on at least one of silicon carbide, silicon nitride, and carbon.

13. The method as recited in claim 10, wherein the interphase material comprises chemical compositions that are non reactive with the non-oxide fibers.

14. The method as recited in claim 10, wherein the deposition temperature for the interphase material is selected to produce a dimensionally unstable interphase morphology that allows interphase shrinkage upon higher temperature exposure.

15. The method as recited in claim 10, wherein the deposition conditions for the non-oxide or oxide matrix on top of the interphase results in an initially dense matrix layer.